logical"; the wall of the perithecium in the Erysiphaceæ does not gradually rot away (p. 273), but opens by a definite rupture; and it is very heterodox to state (p. 143) that the right way to mix the components of Burgundy mixture is exactly the same as with Bordeaux mixture.

High praise must be given to the printers for surmounting so successfully the special difficulties of printing which obtain at Calcutta; the misprints are so rare that the two noticed may be mentioned here—at p. 163 "rust-resting" is printed for "rust-resisting," and at p. 353 "sacospores" for "ascospores."

This work, which is particularly delightful in its readable quality, will inevitably become the "classical" book of reference for both the cultivator and the student of mycology in India. It would be well if in the next edition the author gave more information on "pure culture" methods, enriched as this would be by his intimate knowledge of how to overcome the difficulties that result from the special climatic conditions.

E. S. S.

THE DOUBLE-STAR WORKER'S VADE-MECUM.

The Binary Stars. By Prof. R. G. Aitken. Pp. xiv+316. (New York: Douglas C. McMurtrie, 1918.)

THIS book is issued as one of the series of semi-centennial Publications of the University of California. We are informed in the introduction that "the object of this volume is to give a general account of our present knowledge of the binary stars, including such an exposition of the best observing methods and of approved methods of orbit computation as may make it a useful guide to those undertaking the investigation of these systems; and to present some conclusions based upon the author's own researches during the past twenty years."

The spectroscopic binaries, and also the visual binaries, are regarded as "members of a single species," and the development in recent years of both sections has tended to show that "the only differences between the spectroscopic and visual binary stars are those which depend upon the degree of separation of the two components." Granting this, the compilation of such a volume as that now under review became inevitable; and no one man is more favourably equipped for the task than Prof. Aitken, who, while living in the midst of workers in the spectroscopic section, is himself the incarnation of the visual section. Although not mentioned here, eclipsing binary stars are also regarded as members of the family, and the exhaustive and interesting chap. vii., which the author devotes to them, certainly adds value to the book. There are at present about one hundred and fifty known, and the chapter is based on the researches of Russell and Shapley.

The substance of chaps. i. and ii. is historical, and the author proves that, in both visual and spectroscopic work, American observatories have made double-star astronomy peculiarly their own. It is indeed the fact, and explains why American astronomers are so prominent throughout the book.

Chap. iii. is devoted to observational methods and means, including the micrometer, resolving power, and personal equation. As one would expect, there is much sound and practical advice. On the working catalogue, a difficult subject, it is Prof. Aitken's deliberate judgment that, under average good observing conditions, the angular separation of pairs measured should be nearly double the theoretical limit. Of course, observers with the largest telescopes must not be bound by this, for if they do not measure the very closest pairs the time devoted to their discovery is wasted. The note on the non-use of diaphragms is short and sound. The reviewer found a neutral-tint glass at the eye-end a sufficient and more convenient help.

In chaps. iv. and vi. the author discusses fully the various methods in use for computing orbits of visual and of spectroscopic binaries respectively. He carefully points out the advantages of each method, giving many useful hints, and illustrations by concrete examples. These two chapters have been well considered and developed; they practically exhaust the subject.

Between these two chapters is another in which will be found a welcome description of the spectroscope and of the manner in which accurate measures of displacement in the spectral lines can be made, the photographic portion being illustrated by a minute account of the "Mills spectrograph." In chap. viii. is a table of eighty-seven visual binaries "divided into two groups, the first containing orbits which are at least fairly good approximations, the second the less accurate orbits." But as we are told that "several orbits included in either one of the two groups might find a place in the other," the division seems superfluous. These orbits have been selected in general because they are the most recently computed. There is also a table of 137 spectroscopic orbits, but only 119 are used in the discussions. From a number of interesting results we extract the following relations between the periods and eccentricities:—

46	spec.	bin.,	mean	period	2·75	days,	ecc.	0·047
19	„	„	„	„	7·80	„	„	0·147
25	„	„	„	„	23·00	„	„	0·324
29	„	„	„	„	1·5	years	„	0·350
30	vis.	bin.,	„	„	31·3	„	„	0·423
20	„	„	„	„	74·4	„	„	0·514
18	„	„	„	„	170·0	„		0·539

A relationship so definite must have a physical significance. Later, on p. 221, it is shown that in the Cepheid variables this relation does not hold.

Treating of relative masses of visual binaries, Prof. Aitken remarks: "The most reliable values are those deduced by the late Lewis Boss," and the table on p. 216 is constructed on this idea, the work of several other computers being omitted. This is a pity, and the author himself is not convinced, for later he tells us that Boss

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obtained a value of 1·8 for 85 Pegasi, but *adopted* 1·0; and on p. 233 he also points out that in Sirius we have a system in which is an even greater disparity between mass and luminosity in the two components, and he adopts Boss's computed value. Incidentally, this weakens one of the facts of observation made use of in discussing the "origin of the binary stars." Future progress is dependent on departures from our preconceived ideas.

In chaps. x. and xi. the author is more happy in dealing with his material—a large percentage being his own contribution during the last twenty years—and we are given a number of most interesting tables and results. Here are a few:—(1) At least one in every eighteen stars, on the average, in the northern half of the sky, which are as bright as 9·0 B.D. magnitude, is a close double star visible with the 36-in. refractor. (2) The percentages of double stars by magnitude classes are:

Mag. to 6·5	percentage 11·1	7·6 to 8·0	percentage 6·8
6·6 „ 7·0	„ 7·9	8·1 „ 8·5	„ 5·3
7·1 „ 7·5	„ 7·2	8·6 „ 9·0	„ 4·1

(3) Visual doubles are relatively more numerous in the Milky Way than elsewhere in the sky. (4) Visual binaries as bright as 6·5 magnitude are in excess amongst class G stars, and least in K and M. (5) Visual and spectroscopic binaries of every spectral class increase in numbers as the Milky Way is approached. (6) Spectroscopic binaries as bright as 5·5 magnitude are far the most numerous amongst stars of spectral type B.

To these are added, in chap. xi., the following from points brought out in the previous chapters: (7) The considerable percentage of multiple systems. (8) Close correlation between period and ellipticity. (9) Period and spectral type. (10) Relative brightness and relative masses of the two components. (11) Relatively great mass of a binary compared with the sun. (12) Spectroscopic binaries of class B, on the average, are three times as massive as those of later types.

All these and other minor points are discussed in connection with their bearing on the "origin of the binary stars." Of the three theories: (1) Capture, (2) fission, (3) independent nuclei, the author, having no alternative theory of his own, favours (2). The book contains a mass of interesting data well discussed. The physicist as well as the astronomer will find it a real treasury. It must also appeal to the wider circle of our readers.

THE SCIENCE OF IRON-FOUNDING.

Cast Iron in the Light of Recent Research. By Dr. W. H. Hatfield. Second edition, revised and enlarged. Pp. xvii+292. (London: Charles Griffin and Co., Ltd., 1918.) Price 12*s.* 6*d.* net.

THIS important work on the metallurgy of iron and steel has been enriched, in its second edition, to the extent of some forty-six pages of new matter, including thirty-nine fine reproductions of micro-structures. The chapter on "The Heat Treatment of Cast Iron" has been divided so that the annealing of grey cast iron is treated separately. The new matter includes Prof. Carpenter's valuable contribution on "The Effect of Working Temperatures on Parts of Internal-combustion Engines," the author's report to the Ministry of Munitions on "The Present Position of the Malleable Casting Industry in this Country"—an illogical but welcome inclusion—"The Influence of Sulphur in the Presence of Silicon" (chap. xv.), and "The Limits of Phosphorus in Malleable Castings" (chap. xvi.).

A careful perusal of this work suggests that not much research, recent or ancient, has escaped notice, and everything worthy of note on the theoretical or the quasi-practical side of cast iron is included within the covers of the book. The difficulty is to locate and isolate in a concise form any particular information required. The impression is created that the author has been more or less overwhelmed by the mass of data collected. This results in a sense of uncertainty and a tendency to confusion in the mind of the reader. The author, who is undoubtedly an expert in his subject, would be well advised in any future edition to set out clearly a summary of each chapter, even more fully than has been done in the two new chapters, which in this respect are fairly well equipped.

The portions dealing with heat treatment, especially that which treats of malleable cast iron, bear the true impress of authority, and when this idea is conveyed by the rest of the book it should become the standard work on the metallurgy of cast iron as distinct from iron-founding. All such works should bear the hall-mark of a convincing personality.

The technically trained practical man will find great help in fitting himself either to meet specifications or to account for failures. Graduates and others seeking promising fields of research will find them in plenty, whilst those who delight in public controversy, provided they have easy access to a scientific library (so that the all-too-numerous references may be turned up), will be in clover. In the hope that this book may become the standard classic, we suggest that careful attention should be paid to what may appear to be matters of detail. For example, several graphs do not show clearly the increments which constitute the co-ordinates, and analyses occasionally are far from complete.

It is to be regretted that the chapter on mechanical properties is included in its present form. This should be entirely re-written. Even the pressure of war-time duties does not excuse the use of such terms as "breaking strain in tons per square inch" and "compressive strain." Admitting that cast iron is almost devoid of ductility, "breaking load" is not the correct expression. Again, in dealing with the transverse test, too little attention is paid to the relative value of the maximum stress under the two recognised standard conditions, and there is no

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